

Peddling Influence through Well Informed Intermediaries

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Abstract

This paper studies how a sender with private information can influence the decisionmaker through well-informed intermediaries such as experts, critics or physicians. Both the sender and the intermediary may be independently objective or biased: the objective type passes on the most accurate information while the biased type wants to push a particular agenda but also to appear objective. Although using one's own information is a sign of objectivity, the biased intermediary selectively incorporates the sender's information to push his agenda. When both the sender and the intermediary are sufficiently concerned about reputation, their truth-telling incentives are strategic substitutes. In this case, policy measures encouraging independent reporting may be more effective than those aiming at improving the intermediary's truth telling, but the sender prefers using the intermediary to reporting independently. Moreover, measures raising the sender's reputation cost may worsen the intermediary's lying and make the decisionmaker strictly worse off.

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1 Introduction

In business, politics and everyday life, a party with private information often tries to influence the final user of such information through well-informed intermediaries. In marketing, especially since the widespread use of Internet, online customer opinions or reviews have been shown to boost sales significantly.¹ Some businesses even pay experts or bloggers to promote their image or products while pretending to be independent reviewers (Bandler 2005, NYT 2006). In the medical and health industry, serious questions have been raised concerning pharmaceutical companies who promote their drugs through physicians and medical researchers (NYT 2002, Saul 2006, Carey 2006). These companies exert influence through funding research and giving perks such as paid consultancy positions; through providing physicians with the company's own information about their products ("detailing"), free samples and other gifts; and through "ghostwriting" of journal articles where the purported academic authors have done little of the actual research.²

These influence activities have become more prevalent in the recent years. One recent estimate showed that approximately \$19 billion is spent annually by drug companies for marketing to doctors.³ In particular, the amount of money spent "detailing" physicians has increased from \$3.0 to \$4.8 billion from 1996 to 2000.⁴ Nearly 75 percent of physicians in a national poll said the information they received from pharmaceutical representatives was "very" useful (15 percent) or "somewhat" useful (59 percent).⁵ Many studies also indicate that these influence activities are effective in changing physicians' prescription behaviors, and consequently patients' welfare (Avorn, Chen, and Hartley 1982, Watkins,

¹ In a 2007 Customer Engagement Survey conducted by the global marketing research firm ACNielsen, online consumer opinions represented the third most trusted form of advertising, after word-of-mouth opinions and newspaper ads. Another market research firm, E-consultancy, asked online retailers about the effects of adding customer-generated reviews and ratings. Seventy-seven percent said site traffic increased, and 42 percent reported a rise in the amount of money spent.

² One recent example concerns an *Annals of Internal Medicine* article on Merck's "Advantage" trial of Vioxx, which omitted some trial participants' deaths. The article's first author Jeffrey Lisse said that Merck actually wrote the report, and that "Merck designed the trial, paid for the trial, ran the trial.....Merck came to me after the study was completed." *The New York Times*, "Evidence in Vioxx Suits Shows Intervention by Merck Officials", April 24, 2005.

³ For details, please see "Health industry practices that create conflicts of interest: a policy proposal for academic medical centers," published in the *Journal of the American Medical Association* (Brennan, Rothman, Blank, Blumenthal, Chimonas, Cohen, Golden, Kassirer, Kimball, Naughton, and Smelser 2006).

⁴ See IMS Health Inc. and Competitive Media Reporting, as reported by Kaiser Family Foundation, 2001.

⁵ More than half (55 percent) of a group of "high-prescribing" doctors surveyed by the industry data tracking group ImpactRx said that drug reps serve as their primary source of information about newly approved drugs. Only about one quarter of the doctors (26 percent) mentioned medical journals as their first information source. See "Getting Doctors to Say Yes to Drugs: The Cost and Quality Impact of Drug Company Marketing to Physicians" by the BlueCross BlueShield Association. See <http://www.bcbs.com/betterknowledge/cost/getting-doctors-to-say-yes.html>.

Moore, Harvey, Carthy, Robinson, and Brawn 2003).⁶

This paper presents a simple model of strategic communication through well-informed intermediaries and examine the effect of such communication on the final users of such information. This differs from many existing papers which analyzed how a sender influences the receiver directly by manipulating the information he sends (Crawford and Sobel 1982, Austen-Smith 1990, Dewatripont and Tirole 1999, Morris 2001, Ottaviani and Sorensen 2006, among others). Consider the medical example above, where a pharmaceutical company may promote its drugs through physicians, medical researchers, or through direct advertising. How are the physicians influenced by the pharmaceutical company, especially if their information disagree? How do the pharmaceutical company's truth-telling incentives interact with those of the intermediary's? What is the net impact on the patients (or the broader medical community)? When does the company prefer direct advertising instead? This paper addresses these questions by investigating the strategic considerations of the sender and the intermediary. It also applies these insights to study the effectiveness of policy measures aiming at improving reporting accuracy, which has implications for professional ethical rules and campaign finance laws.

In this model, a sender receives a private signal about the state of the world and sends a message to an intermediary who also has an independent, private signal. Because this paper focuses on a well-informed intermediary who has expertise such as physicians and researchers; or has experience in a market for credence goods, the intermediary's signal is assumed to be more accurate than that of the sender's.⁷ The intermediary in turn sends a message to the decisionmaker, who takes an action based on what she hears.⁸ Afterwards, the true state becomes observable. The sender and the intermediary may be independently one of two types: objective or biased. An objective agent always passes on the most accurate information he has, while a biased agent has a private agenda: he wants the decisionmaker to

⁶ Further examples include that of General Motors Corp., which found itself spending \$52 million in 2001 for prescriptions that physicians wrote for Prilosec, a widely promoted and expensive drug for severe and persistent heartburn — even though a subsequent analysis found that 91 percent of the patients receiving prescriptions had no prior prescription related to heartburn and no prior diagnosis of the problem. A recent analysis of National Ambulatory Medical Care Survey data found that since 1991, “physicians are increasingly turning to expensive, broad-spectrum agents, even when there is little clinical rationale for their use” compared to simpler, generic antibiotics. By 1998-99, more than one in five adult prescriptions for broad-spectrum antibiotics and one in seven prescriptions for children were for conditions that were primarily viral, such as the common cold or acute bronchitis.

⁷ In a companion piece, Li (2007b) considers the case when the intermediary has little information of his own and acts as a pure intermediary. The strategic interactions between agents as well as policy implications are very different due to the lack of information aggregation considerations, see further details in Section 5.

⁸ Throughout this paper, the sender and the intermediary are male and the decisionmaker is female.

act in a particular way. In addition, biased agents are concerned about their reputations: they want to appear objective after the decisionmaker has observed the true state.

Because the intermediary's signal is more accurate than any message of the sender's even without distortion, the objective intermediary always reports his own signal truthfully. But the biased agents face a tradeoff between appearing objective and inducing the decisionmaker to take an action in favor of his bias. The first result is that a biased intermediary may selectively incorporate the sender's message if his signal does not support his bias. Specifically, he is more likely to lie against his own, superior information if the sender's message supports his agenda than if it does not. Moreover, the less the intermediary is concerned about his reputation, the more likely he lies against his own information (and sometimes both their information) to push his agenda. This gives rise to a *bad information aggregation* effect because the intermediary's signal is the most useful to the decisionmaker.

It may appear that since the decisionmaker cannot observe the sender's message, the sender and the intermediary should share the blame if the intermediary's message turns out to be wrong, which makes it easier for each agent to lie more than he would have reporting alone. In this model, however, if the agents are sufficiently concerned about reputation, just the opposite is true: if the intermediary gets less blame for sending a wrong message, it becomes cheaper for the sender to lie as well. The reason is that since the objective intermediary always reports his signal, independence from the sender's influence is the best sign of objectivity. Therefore, the intermediary cannot blame any mistake on being misled by the wrong source. Suppose that the intermediary is slightly more truthful, then his message becomes more credible and more effective at agenda pushing. Moreover, because he reports more independently now, the decisionmaker assigns him relatively more credit (if the message is not associated with bias) or blame (if the message is a biased one). Consequently, the sender's net reputation cost falls because it becomes less responsive to the message the decisionmaker receives. But the sender still gains from the additional credibility the intermediary's message now enjoys, hence he lies more. Similarly, if the sender is more truthful, his message becomes more useful. This actually reduces the perceived objectivity of the intermediary from truthful reporting, because he may have just followed the sender. As a result, his reputation cost of lying falls and the intermediary lies more. This gives rise to a *substitution effect*, which is the second result of this paper: one biased agent's truth-telling incentives decrease in those of the other's if they are sufficiently concerned about their reputation.

The decisionmaker may consider policy measures to increase the reputational cost of the sender to lie. Paradoxically, due to the bad information aggregation effect, this may make her worse off if both the sender and the intermediary have low levels of reputational concerns. The reason is that the sender always pushes his agenda before, thus his message has little influence on the intermediary. If he reports more truthfully, his agenda pushing message becomes more credible and leads the intermediary to lie more. Because the intermediary has a better signal, the decisionmaker may receive lower quality information and hence make worse decisions. On the flip side, rules and policies imposing higher penalties on the intermediary can be quite effective because it increases the intermediary's reporting accuracy significantly. If both the sender and the intermediary have high levels of reputational concerns, however, the substitution effect makes these policy measures relatively ineffective, because they may boost the intermediary's truth telling but reduce that of the sender's. The overall probability of the decisionmaker receiving a wrong message may fall very little.

In comparison, independent, simultaneous communication from both agents is considered where the decisionmaker receives two messages before taking an action. At first glance, it may seem that one agent's message imposes some discipline on how much the other lies due to reputational concerns. With independent communication, however, each biased agent pays his own reputation cost because he is evaluated based on his message and the later observed true state. Therefore the presence of another message only affects the (expected) marginal impact of each agent on the decisionmaker's action, which is shown to decrease in the other agent's reporting accuracy: the biased agents' truth-telling probabilities are strategic complements. To see this, note that if one agent becomes more truthful, it increases the probability that the decisionmaker hears a message against the biased agent's agenda. Therefore if he lies, his message is more likely to be contradicted and becomes far less influential, because the decisionmaker is less likely to believe in his agenda than if there is a concurring message. Overall, agenda pushing becomes less effective, but the reputation cost is unaffected, thus the other agent lies less as well. The complementarity suggests that the decisionmaker may want to encourage independent reporting, especially if both agents have high levels of reputational concerns. If, however, both agents are so biased that they always lie, two agenda-pushing messages may reinforce and strengthen each other, exacerbating the decisionmaker's losses from taking a wrong action.

Both types of communication are widely used in different environments. Which environment does a

biased sender prefer in term of getting a higher ex ante expected payoff? This paper shows that, on the one hand, if the sender cares little about his reputation and the intermediary is considered very biased, he prefers sending his own message. Because here the intermediary's message is not credible and the sender does not want to waste his information: his independent message can push the decisionmaker's action further in favor of his bias. On the other hand, if both of them have sufficiently high levels of reputational concerns, the sender prefers using an intermediary instead because his message still has a positive impact on the intermediary, but his reputation cost is negligible since the intermediary uses his own message with a high probability.

Several recent papers consider the case where intermediaries may be affected by a biased sender. Durbin and Iyer (2006) consider the case where intermediaries (advisors) may be bribed by an uninformed and biased third party to support the third party's bias. All advisors are corruptible, but the good advisor is more costly because his interest is more closely aligned with the decisionmaker. Moreover, if the advisors have reputational concerns, a bribe may be necessary for the advisor to report his true signal if it happens to favor the biased third party. This paper focuses on the information transmission aspect: a source can influence an intermediary by altering his confidence in the signal, and thus the decisionmaker's action. But it can be extended to the case where cash bribes are also employed. In a similar vertical structure but with a different focus, Inderst and Ottaviani (2007) study the incentive problems faced by an intermediary (such as a sales agent) if he has to perform two tasks: one for the seller and the other for the buyer. Because of the inherent conflict of interest, they show how the firms design the intermediary's compensation scheme to balance his incentive to increase sales and to provide good advice to the buyer.

From a social network perspective, this paper is also related to DeMarzo, Vayanos, and Zwiebel (2003), who show that the influence of one's action on others depend not only on his information accuracy, but also on his position in a given social network. Their work takes the orthogonal approach from the present paper: they focus on richer sets of social networks, allowing each agent to report truthfully and assuming that the agent has "persuasion bias", namely they fail to account for possible repetitions in the information that reaches them. Instead, this paper focuses on a very simple way of indirect communication and considers strategic agents who make rational inference of any information they receive given the possible source(s) and the bias involved.

The rest of this paper proceeds as follows. Section 2 sets up the basic model and Section 3 analyzes the equilibrium of the indirect communication game and also studied the normative question of improving the intermediary’s truthful reporting. In comparison, Section 4 studies independent reporting by the agents and the preference of a biased sender. Section 5 discusses several main assumptions and Section 6 concludes. All the proofs are contained in the Appendix.

2 Setup

There are three agents: A , B and C . Agent C is the decisionmaker, whose optimal action depends on the state of the world $\eta \in \{0, 1\}$. Each state occurs with equal probability. Agent C chooses an action $a \in \mathfrak{R}$ to maximize her payoff, which is simply assumed to be the quadratic loss function $-(a - \eta)^2$. Her optimal action is thus equal to the probability she attaches to $\eta = 1$. In the health industry example, the true state refers to the effectiveness of a drug: it may be “useless” (state 0) or “useful” (state 1). And the decisionmaker is the patient(s) who needs to decide how much to rely on this drug.

Although C has no information about the state, she has access to some partially informed sources: agent A and B . Agent $i = A, B$ receives an informative signal s_i about the true state: $Pr(s_i = 1|\eta = 1) = Pr(s_i = 0|\eta = 0) = p_i > \frac{1}{2}$. These signals are independent conditional on the state. As mentioned in the introduction, B ’s signal is assumed to be more informative than that of A ’s: $p_B > p_A$, reflecting the fact that B either has expertise or experience in evaluating a product. For example, a physician is better at figuring out whether a drug is useful for her patients. For simplicity, assume that A ’s signal is relatively uninformative: p_A is sufficiently close to $\frac{1}{2}$.⁹ In the main model, given his signal, A has an opportunity to send a private message $m_A \in \{0, 1\}$ to B . Next, B sends a private message $m_B \in \{0, 1\}$ to C given m_A and his own signal s_B . Information is assumed to flow only in one direction, from A to B to C . An agent can only observe the message sent directly to him. Moreover, all messages are assumed to be observable but unverifiable, thus no transfers can be made based on the messages.

Agent i may be either objective (type o) or biased (type b). Each agent’s type is independently drawn from $t_i = \{o, b\}$: $Pr(i = o) = \theta_i$, $Pr(i = b) = 1 - \theta_i$. Parameter θ_i , which captures agent i ’s existing reputation, is referred to as i ’s prior objectivity in this paper. An objective agent is assumed

⁹ This assumption simplifies the equilibrium characterization in Section 3. More precisely, for any given parameters, there exists a cutoff value of A ’s signal quality \bar{p}_A such that all the results hold for $p_A \leq \bar{p}_A$.

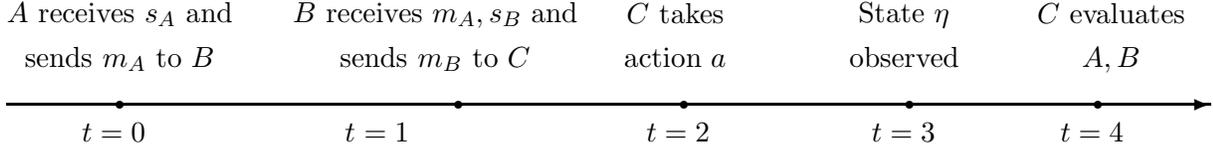


Figure 1: Timeline of the Indirect Communication Game

to be behavioral: he always passes on the information he believes to be the most accurate given what he knows. This can be justified either on the grounds of professional ethics or institutional goals.¹⁰

A biased agent always favors action $a = 1$, but he also wants to appear objective due to reputational concerns. Let π_i be the decisionmaker’s posterior estimate of agent i ’s objectivity after she observes the true state. Then the payoff functions of biased agent A and B are given respectively by:

$$u_A(\pi_A) = a + \alpha\pi_A \quad \text{and} \quad u_B(\pi_B) = a + \beta\pi_B.$$

The first half is C ’s action given what she hears from B .¹¹ Clearly, the closer C ’s action is to $a = 1$, the favorite agenda of a biased agent, the better off he is. The second half of the payoff function shows that a biased agent wants to appear objective, which is a reduced form for the biased type’s concerns for his future reputation, e.g., a financial analyst cannot exert any influence on his readers if he is perceived to be biased. Note that A and B may care about C ’s impression for different reasons. The parameters $\alpha, \beta \in [0, \infty)$ are the respective weight A and B place on C ’s (eventual) view of their objectivity. Another interpretation of these weights is that the ratios $\frac{1}{\alpha}, \frac{1}{\beta}$ reflect the extent, or the intensity, of A, B ’s bias. Thus the lower is α (β), the more is A (B) considered a “partisan” in that he cares more strongly about pushing his agenda. In summary, the indirect communication game is illustrated in Figure 1.

In this game, biased agent i sends a message $m_i \in \{0, 1\}$ as a function of his information. Given message m_B , C chooses an action a . Later, she rationally updates her opinion on A and B ’s objectivity π_A, π_B as a function of their prior objectivity, the message received and the observed state. The equilibrium concept used in this paper is that of perfect Bayesian equilibrium (PBE): each agent chooses a message to maximize his expected payoff, given his information, the other agent’s strategy as well as

¹⁰ For instance, Lahey Clinic, one of the major U.S. adult care hospitals writes: “Because good ethics begins with good medicine, the patient or DPAHC must receive accurate medical information and must understand it.”

¹¹ Because the primary focus of this paper is on biased A and B , how C uses her updated beliefs of the agents is left unmodeled. In models where C faces important future decisions, this updated belief itself may have value as shown in Li (2007a).

C 's action and inferences.

Although messages in this model are private and unverifiable, this is not a cheap talk game and no babbling equilibria exist. The reason is that the objective agents always send the most accurate information, hence any message is informative and useful to C . This also implies that there is an endogenous cost of fabricating/passing on a biased message: when a biased agent pushes his agenda, he deviates from his best estimate of the state and thus is more likely to be wrong. In expectation, he is less likely to be considered objective in the eyes of C .

Before turning to the analysis, it is useful to keep in mind a few other interpretations of the model:

1. Agent A is a company launching a new movie, CD or some other consumer products. The state is the quality of the product. Agent B is a reviewer or critic who is better able to assess the quality. Agent C is the consumer who has no knowledge one way or another without the reviews.
2. Agent A is a mortgage broker (or banks and other lenders) and the state is the value of a property. If the broker (or the lender) is biased, it wants a higher appraisal so as to boost the commissions (or loans) from financing the purchase. Agent B is a real estate appraiser who has the expertise in deciding the market value of a property. The decisionmaker is the perspective homeowner who needs to decide how much, if any, to bid for the property.¹²
3. Agent A represents a grassroots political group who may be genuinely concerned about a policy or may be biased toward certain special interests. Agent B is a legislator overseeing this policy related area and makes a recommendation about this issue. Agent C is the voters (or its proxy the legislature) who need to know about the true consequences of this policy.

3 Peddling Influence through B

This section considers how communicating through a well-informed intermediary B affects all biased agents' truthful reporting, which depends crucially on the behavior of the objective agents they are partially trying to emulate. Consider A 's influence, if any, on an objective intermediary first:

¹² New York's attorney general announced a lawsuit against eAppraiseIT, a leading appraisal management firm, for caving in to pressure from Washington Mutual to use a list of "proven appraisers" who he claims inflated home appraisals. Associated Press, November 1, 2007.

Lemma 1 *Objective B always reports his own signal regardless of A's message: $m_B = s_B$.*

This lemma shows that an objective intermediary always follows his own signal, which is a better source of information than that of A's, whether A's message confirms or contradicts it. It also implies that within the confines of this model, information aggregation is less important to the decisionmaker than hearing from objective B, a well-informed expert.¹³

3.1 Biased Intermediary's Behavior

Although A has no influence on an objective intermediary, his message does have two effects on a biased one. The first is a bad information aggregation effect. Because A's message affects B's own estimates of the true state, which affects B's reputation, B may be influenced by m_A even though it is not efficient for the decisionmaker. The second effect is on the credibility of B's message: if B may be influenced by A, the decisionmaker would take such influence into account before taking an action. This subsection analyzes how B's behavior depends on A's message and his own reputational concerns.

Suppose that biased A passes on a signal that supports his agenda truthfully, but a signal that is against his agenda probabilistically: $m_A = 1$ if $s_A = 1$, but $m_A = 0$ with probability $x \in [0, 1]$ if $s_A = 0$. Also, suppose that biased B chooses the following continuation strategy: reporting $m_B = 1$ if his signal supports his bias ($s_B = 1$). But if $s_B = 0$, he reports $m_B = 0$ with probability y_2 if A's message confirms his signal ($m_A = 0$); but reports $m_B = 0$ with probability y_1 if A's message contradicts his signal ($m_A = 1$). Both A and B's strategies are later shown to be part of the equilibrium strategies. Intuitively, if $y_1 \neq y_2$, the degree to which B is influenced by A depends on whether A's message concurs with his signal or not. The higher are the probabilities y_1, y_2 , the more truthful B is. If $y_1 = y_2 = 1$, biased B reports his signal truthfully; and if $y_1 = y_2 = 0$, he always reports $m_B = 1$.

Given these strategies, biased B chooses m_B to maximize:

$$EU_B(m_B|s_B, m_A) = Pr(\eta = 1|m_B) + \beta E_\eta[Pr(B = o|m_B, \eta)|s_B, m_A].$$

The first part is C's action given his message, and the second part is his expected posterior objectivity given his private information s_B and m_A , where the expectation is taken with respect to η . To begin

¹³ B's message is best thought of as a simple recommendation, and it is the simplest way to show the direction of biased B's distortions given both his signal and A's influence. Allowing B to convey both A and his own information is discussed further in Section 5.

with, observe that the effectiveness of B 's message is measured by the difference his message can induce in C 's action: $Pr(\eta = 1|m_B = 1) - Pr(\eta = 1|m_B = 0)$. This difference is always positive, due to the presence of objective B , even if biased B lies completely. Also, A 's message affects the effectiveness of m_B if B lets through A 's information selectively. For example, $m_B = 0$ constitutes very strong evidence against biased agents' agenda: it indicates that both A and B 's signal are likely to be 0.

Moreover, biased B is also concerned about how m_B affects his expected posterior objectivity:

$$E_\eta[Pr(B = o|m_B, \eta)|s_B, m_A] = \sum_\eta Pr(\eta|s_B, m_A)Pr(B = o|m_B, \eta).$$

Clearly, A 's message influences B 's estimate of the true state $Pr(\eta|s_B, m_A)$: it increases B 's belief in his signal if they agree, but decreases it otherwise. The following proposition characterizes B 's equilibrium behavior after receiving m_A .

Proposition 1 *Given x , there exists a unique continuation equilibrium in which biased B reports truthfully if his signal supports his agenda: $m_B = 1$ if $s_B = 1$. If B 's signal is against his agenda ($s_B = 0$), the equilibrium is one of three possible types. Either a total distortion equilibrium in which he always lies: $y_1 = y_2 = 0$; or a strong distortion one in which he reports $m_B = 1$ if $m_A = 1$, and reports $m_B = 0$ with some probability if $m_A = 0$: $y_1 = 0, y_2 \in (0, 1]$; or a weak distortion one in which he reports $m_B = 0$ if $m_A = 0$, and reports $m_B = 0$ with some probability if $m_A = 1$: $y_1 \in (0, 1), y_2 = 1$.*

Proposition 1 shows that if $s_B = 0$, biased B is more apt to lie if A 's message supports, rather than contradicts, his agenda. Here he considers A 's message for further evidence: since m_A is always informative due to the presence of objective A , $m_A = 1$ lends some support for his agenda while $m_A = 0$ is another strike against it. This explains the different types of (continuation) equilibria: if B has little reputational concerns, he always lies. But if B is sufficiently concerned about his reputation, he is always more truthful if $m_A = 0$ than if $m_A = 1$: $y_2 > y_1$ if $\max\{y_1, y_2\} > 0$. To see this, note that for B , the benefit of agenda pushing is the same for all signals and messages, but it is more expensive in term of posterior objectivity to lie if $m_A = s_B = 0$ — lying against both their signals often leads to the worst reputation $Pr(B = o|m_B = 1, \eta = 0)$. If $m_A = 1$ instead, B believes less in his own signal, thus his expected reputation cost of lying is smaller. Consequently, if B reports $m_B = 1$ after $m_A = 0$ (even if just probabilistically), he must strictly prefer doing so after $m_A = 1$, which gives rise to a strong

distortion equilibrium. Or, B may only report $m_B = 1$ sometimes if $m_A = 1$, which gives rise to a weak distortion equilibrium. In any case, B will never be completely honest: if so, his message will have the largest impact on C and he pays no reputation cost.

Which equilibrium may occur depends on B 's reputational concerns, or equivalently, how strongly he feels about pushing his agenda. If β is sufficiently low ($\beta \leq \underline{\beta} \equiv \frac{1}{1+(1-\theta_B)}$), he always lies. As β increases, the continuation equilibrium is the strong distortion one: lying against both his highly informative signal and A 's information is still not too costly in term of reputation. But eventually, as β becomes sufficiently high, the weak distortion equilibrium occurs. This also implies that B 's response to a change in β , perhaps due to changes in regulations (disclosure laws) or professional ethical standard (medical board recommendations), varies depends on his existing reputational concerns and the magnitude of such changes.

Interestingly, biased B 's net reputation cost from lying decreases in x : the more truthful A is, the less costly it becomes for him to lie. After all, we may think that since C cannot observe A 's message, A and B should share the blame if the message turns out to be wrong. This may make it more costly for B to lie if A is more truthful, because C attributes more blame to B . In this model, however, the more truthful A is, the less likely m_A is biased toward $\eta = 1$, which has two effects. The first one is that $m_A = 1$ is more credible, therefore B is more likely to follow A 's message and report $m_B = 1$ due to the bad information aggregation effect. Second, because biased A reports $m_A = 0$ with a higher probability and in equilibrium $y_2 > y_1$, it is more likely for biased B to report $m_B = 0$ as well if x increases. In this way, $m_B = 0$ becomes a less positive signal of independent reporting (and hence B objectivity); similarly, $m_B = 1$ becomes a less negative signal of B 's objectivity because the chance of being influenced by $m_A = 1$ is smaller. Both these effects work together in reducing B 's net reputation cost, the difference between reporting $m_B = 0$ and $m_B = 1$, making it cheaper for B to lie if A is more truthful.

Intuitively, any sign of being influenced is a sign of bias, which explains why B can not shift any blame to A . As an example, note that C 's posterior estimate $Pr(B = o|m_B = 0, \eta = 1) > Pr(B = o|m_B = 0, \eta = 0)$. That is, given $m_B = 0$, B is considered more objective even though his message is inaccurate. If $m_B = 0$ but $\eta = 1$, C thinks that it is likely that $m_A = 1$ — because A 's signal s_A is more likely to be 1 even without distortion — but B did not follow m_A . This suggests that independence

and trusting one's own information may be a more prized sign of objectivity even though sometimes the prediction turns out wrong.

3.2 Equilibrium of the Indirect Communication Game

The previous subsection shows that biased B is more willing to lie against his highly informative signal to push his agenda if A 's message supports his bias. Clearly, objective A always reports his signal which is his best information. This subsection studies how biased A chooses a message m_A to maximize his expected payoff:

$$E_{m_B}[Pr(\eta = 1|m_B) + \alpha E_\eta[Pr(A = o|m_B, \eta)]|s_A, m_A].$$

Biased A has a new consideration: he can only influence the decisionmaker C and later be judged for his objectivity through B 's message. Despite this uncertainty over what the decisionmaker hears, the pivotal event for A , which determines his truthful reporting, is the difference in B 's messages induced by m_A . Formally, the difference in A 's expected payoff $EU_A(m_A = 1|s_A = 0) - EU_A(m_A = 0|s_A = 0)$ if he reports $m_A = 1$ instead of $m_A = 0$ is proportional to $(1 - \theta_B)(y_2 - y_1)$. Clearly, if B is known to be objective ($\theta_B = 1$); or if B always lies to push his agenda ($y_1 = y_2 = 0$), A 's message has no impact on either C 's action, or his own reputation. The gap between y_2 and y_1 affects the magnitude of A 's influence. If $s_A = 0$, B is more likely to receive $s_B = 0$, and a message of $m_A = 1$ is more likely to change B 's message than $m_A = 0$ because $y_2 > y_1$. By the same token, In C 's posterior evaluation, A 's net reputation cost depends more strongly on the case of $\eta = 0$ than $\eta = 1$, because B is most likely to have received $s_B = 1$ if $\eta = 1$, in which case A has no influence.

Biased A and B compare their agenda pushing effectiveness against possible reputation losses. Their equilibrium behavior are described by the following result.

Proposition 2 *Biased A reports truthfully if his signal supports his agenda: $m_A = 1$ if $s_A = 1$.*

(2.1) *Biased A has no influence, $x \in [0, 1]$, if B plays a total distortion equilibrium, which occurs if B has sufficiently low reputational concerns, or if B 's prior objectivity is sufficiently high.*

(2.2) *Biased A has influence, $x \in [0, 1)$, if B plays a strong or weak distortion continuation equilibrium. A always reports $m_A = 1$ if α is sufficiently low; or if θ_A is sufficiently close to 1. Moreover, for any α , $x = 0$ if β is sufficiently high.*

Since objective B is never influenced, Proposition 2 shows that A has no influence on the decision-maker if biased B always reports $m_B = 1$. In this case, A 's information is completely lost: it does not affect the outcome in term of C 's action, nor does it has any impact on his own reputation. Thus A is free to report in any way. A only has influence if B may alter his message because of m_A , in which case A never reports completely truthfully because his information can affect C 's action indirectly. In fact, if A 's influence on B is sufficiently small, which occurs if β is sufficiently high, A always reports $m_A = 1$ regardless of his own reputational concerns. The reason is that biased B follows his own signal very closely due to his reputational concerns ($y_2 = 1, y_1 \approx 1$), thus C attributes very little blame to A regardless of m_B . Because A still benefits strictly from B 's agenda pushing at a negligible reputation cost, he lies completely.

In a weak distortion equilibrium, if A is sufficiently concerned about his reputation and B has moderately high level of reputational concerns such that $x > 0$, the agents' truth-telling incentives are strategic substitutes. To see this, first note that A 's agenda pushing benefit increases in both agents' truthful reporting: $m_B = 1$ becomes more convincing if the agents are more honest. Second, A 's net reputation cost decreases in B 's truth telling probability y_1 because it becomes less sensitive to B 's message, right or wrong. For instance, suppose that the true state $\eta = 0$ and consider how A 's posterior objectivity changes as a result of a higher y_1 . On the one hand, $Pr(A = o|m_B = 0, \eta = 0)$ decreases in y_1 because C believes that $m_B = 0$ is more likely a sign that B is more honest and didn't follow $m_A = 1$, thus it is a less positive signal of A 's objectivity. On the other hand, $Pr(A = o|m_B = 1, \eta = 0)$ increases in y_1 , because if B is more truthful, C thinks that it is more likely that B receives the wrong signal instead of being influenced by A . As a result, the difference between these two posteriors—the major part of A 's net reputation cost—decreases in y_1 . Together, A exerts a stronger influence at a lower reputation cost, A could afford to lie more. In equilibrium, x and y_1 decrease in each other.

In a strong distortion equilibrium, however, interactions between the agents' truth-telling incentives depend on the parameter values because both A 's agenda pushing effectiveness and his reputation cost increase in y_2 . It is important to note that here biased B is actually following m_A : if $m_A = 1, m_B = 1$; but if $m_A = 0$, and y_2 increases, biased B reports $m_B = 0$ more often. This means that A and B are sharing blame in this case. If B 's message is not biased, it is more likely that A 's message is not biased either; but if B 's message turns out wrong, A is more likely to have lied as well. For instance, consider

$Pr(A = 0|m_B = 0, \eta = 0)$: what does C think of A in this case? In a strong distortion equilibrium, C believes that it is more likely that A sends $m_A = 0$ and that B has followed. Otherwise, B would always send $m_B = 1$; similarly, $Pr(A = 0|m_B = 1, \eta = 0)$ decreases in y_2 . This effect may be sufficiently strong that A reports more truthfully if B does so.

The equilibrium of this game shifts with B 's weight on reputation. When $s_B = 0$, there exists cutoff values β_1 and $\bar{\beta}$ such that if $\beta \in [\underline{\beta}, \beta_1]$, the strong distortion equilibrium occurs; and if $\beta \geq \bar{\beta}$, the weak distortion equilibrium occurs.¹⁴ Interestingly, if biased B has moderate reputational concerns, e.g. $\beta \in [\beta_1, \bar{\beta}]$ and A 's reputational concerns are not so low that he always reports $m_A = 1$, multiple equilibria involving both strong and weak distortions may exist. In this range, B 's behavior is very sensitive to how accurate A 's message is, especially if B 's signal quality is close to that of A 's. If A is very truthful because he has very strong reputational concerns, $m_A = 1$ is more credible, which means that B is less likely to be wrong if he reports $m_B = 1$ to push his agenda. This may give rise to a strong distortion equilibrium. If, however, A is very biased and $m_A = 1$ is not very credible, lying and reporting $m_B = 1$ is more expensive for B , thus a weak distortion equilibrium may exist as well.¹⁵

3.3 Information Loss for the Decisionmaker

If well-informed intermediaries are influenced by sources with inferior and potentially distorted information, the decisionmaker may want to encourage independent reporting by making it more expensive for intermediaries to lie by raising β ; or to encourage the sources to be more truthful by raising α . In real life, such measures may take the form of more stringent and thorough medical board reviews; or stricter regulations on pharmaceutical companies.

The decisionmaker is only concerned about minimizing her expected loss from taking the wrong action. Recall that her optimal action given m_B is to set $a = Pr(\eta = 1|m_B)$, and her expected payoff is simply $-E_\eta E_{m_B}[(Pr(\eta = 1|m_B) - \eta)^2|m_B]$. Distortions by the biased agents affect the accuracy of m_B and thus her payoff in two ways: through the credibility of B 's message; and through the overall probability a particular message reaches her. Consider first how changing the intermediary's reputational concerns affect the agents' reporting accuracy through their strategic interactions.

¹⁴ These cutoff values are defined in the proof of Proposition 2 in the Appendix.

¹⁵ For instance, if $\alpha = 10, \theta_A = \theta_B = 0.5, p_A = 0.7, p_B = 0.75$, then multiple equilibria exist for $\beta \in [1.55, 1.62]$.

Proposition 3 *There exists a cutoff value $\underline{\alpha}$ such that if $\alpha \geq \underline{\alpha}$ and $\beta \geq \underline{\beta}$, then in the weak distortion equilibrium, x (weakly) decreases in β while y_1 increases in it. In the strong distortion equilibrium, if p_B is sufficiently high, x and y_2 increase in β .*

Proposition 3 implies that a small increase in β is most effective if the intermediary has low to moderate amount of reputational concerns. This is when the worst types of distortion occurs: biased B lies with a high probability despite his high quality signal in a strong distortion equilibrium. When β increases, B report more truthfully, thus C attributes more blame to A and makes it more expensive for A to lie. When both agents become more truthful, B 's message becomes more credible and the overall probability of C receiving a wrong message falls. Therefore, C 's expected payoff increases sharply and any policy measures raising β yields the highest marginal benefit if $\beta \in \{\underline{\beta}, \bar{\beta}\}$. In the health industry example, strengthening medical board review process or disclosure rules may drastically improve the credibility of the medical profession: both because the physicians are less influenced and also because the source (drug companies) may become more truthful in revealing side effects.¹⁶

Such measures, however, have no effect or a very small positive effect on C if B has very low or very high reputational concerns: B does not change his behavior in a total distortion equilibrium unless β increases significantly. If β is very high, a weak distortion equilibrium exists in which an increase in β leads A to lie more (or completely if β is sufficiently high), which partially offsets B 's truthful reporting. In this region, C 's expected payoff increases very gradually, not only because B 's message may not necessarily become more credible due to A 's increased lying, but also because the overall probability of receiving message $m_B = 1$ does not decrease much. In fact, the marginal benefit of raising β approaches zero.¹⁷

The decisionmaker may also consider measures increasing α by imposing higher fines for pharmaceutical or financial institutions to influence physicians or independent financial analysts.¹⁸ Interestingly,

¹⁶ The settlement of the \$185 million class action lawsuit against Bristol-Myers Squibb in January 2006 shows that they paid physicians to exaggerate, in major medical meetings, the benefits of their drug for patients with high blood pressure and heart failure; these physicians also failed to report publicly on substantial numbers of life-threatening drug complications which they knew, from their close relationship to the company, to exist.

¹⁷ Even though here we only consider measures affecting the reputational cost of the agents and ignore monetary fines or any costs required to implement and enforce such measures, such costs can be easily incorporated. For example, measures raising β for intermediaries sufficiently concerned about their reputations makes C worse off if a small fixed cost is involved.

¹⁸ In 2006, the world's pharmaceutical companies spend an estimated \$19 billion annually to influence doctors. In comparison, the drug-makers spent only almost \$5 billion to reach out to consumers with direct advertising. They sponsor teaching programs and research at universities across the country, as reported by the Journal of the American Medical

note that the decisionmaker C may be worse off from doing so if A and B both have low to moderate levels of reputational concerns. The reason is that A always reports $m_A = 1$ if $\alpha \leq \underline{\alpha}$, thus his message is not very credible and the intermediary does not follow it closely (y_2 is very high). However, a small increase in α makes A more truthful, thus his message more useful to biased B . The aforementioned bad information aggregation implies that B follows m_A more closely (y_2 becomes smaller). Because the decisionmaker faces severe information loss in a strong distortion equilibrium, the net effect may be negative.¹⁹ This suggests that small increases in the source’s reputational concerns may worsen the intermediary’s incentives when it counts the most. The decisionmaker should consider policies that lead to large changes in A ’s reputational concerns, or policies targeting the intermediary instead.

4 Comparing Communication Methods

For legal or institutional reasons, in some environments such as advertising, A conveys his information to the decisionmaker without using intermediaries; in some other environments such as marketing and the health industry, exerting influence through intermediaries is common. What are biased A and B ’s incentives to convey their information truthfully if they send independent messages? How does it affect the decisionmaker’s expected payoff? Independent reporting serves as a natural benchmark, because A and B both possess informative signals and may influence the decisionmaker directly.

4.1 Independent Reporting

Suppose instead of communicating through an intermediary, A sends a message to C , who now receives both m_A and m_B before choosing an action. A, B ’s signals are informative and independent conditional on the true state: $p_A > \frac{1}{2}, p_B > \frac{1}{2}$, and all the other assumptions remain. The presence of multiple messages affects the tradeoff a biased agent faces primarily by changing the marginal impact of his message on the decisionmaker’s action, and thus his agenda-pushing effectiveness. Observe that when agent A reports independently, biased A maximizes:

$$E_{m_B}[Pr(\eta = 1|m_A, m_B)|s_A] + E_\eta[Pr(A = o|m_A, \eta)|s_A].$$

Association. They also pay medical researchers for lending their names to articles written by company insiders and submitting them to highly respected medical journals.

¹⁹ For instance, if $\theta_A = \theta_B = 0.5, p_A = 0.7, p_B = 0.95$, then for $\beta \in [0.7, 0.9]$, an increase from $\alpha = 1$ to $\alpha = 2$ reduces C ’s expected payoff.

The first part of A 's expected payoff, his influence on C , differs from the case of indirect communication because it now depends on B 's message as well. It is worth noting that the second part, A 's expected posterior objectivity, is independent of m_B . It may seem that the presence of another message may affect A by imposing additional discipline, but because C knows the true state when she evaluates an agent, A 's posterior objectivity depends solely on his message. All the strategic interactions between the agents enter through their messages' influence on C 's action, instead of also through the agents' reputational concerns as in the case of indirect communication.

Each agent chooses a message after comparing the net marginal impact his message has on C 's action with the net loss of reputation if he lies.

Proposition 4 (Independent reporting) *Biased agent $i = A, B$ always report $m_i = 1$ if $s_i = 1$. If $s_i = 0$,*

(4.1) biased i always reports $m_i = 1$ if he attaches little weight to his reputation (α or β is sufficiently low); or if his prior objectivity is very high (θ_A or θ_B sufficiently high).

(4.2) biased i report $m_i = 0$ truthfully with probability $x_i > 0$ if his weight on reputation is sufficiently high or if his prior objectivity is moderate. Moreover, the agents' truth-telling probabilities are strategic complements.

The key of Proposition 4 is that for each agent, the net benefit from agenda pushing decreases in the other agent's truth telling when it matters. Suppose that $s_A = 0$ and B reports more truthfully, it has two effects on A . First, if $m_B = 1$, A 's marginal impact on C 's action by choosing $m_A = 1$ versus $m_A = 0$ decreases—the more truthful B is, the less responsive C is to A 's message. Second, an opposing effect exists because if B is more honest, he is more likely to report $m_B = 0$ (given $s_A = 0$). In that case, $m_A = 1$ has a stronger influence on C who receives at least one message in support of his agenda. However, it can be shown that the fall in A 's marginal impact in the event $m_B = 1$ dominates, because relative to the case with objective agents only, $m_A = 2$ is more likely to be distorted and less credible if $\eta = 0$. Intuitively, the more C thinks that $\eta = 0$, the less she changes her action based on a message associated with bias. The message $m_B = 0$ implies that $s_B = 0$, thus A 's agenda pushing is less effective. In this way, A 's (expected) marginal impact on C falls but his net reputation cost remains the same. As a consequence, A lies less than he would as the sole source of information. Moreover, with

independent reporting, A and B 's truthful reporting probabilities x_A, x_B move together.²⁰

In particular, this implies that in comparison with either indirect communication, or reporting as the sole source of information (only A or B sends a message), a biased agent is less likely to lie completely. Formally, even if biased i always reports $m_i = 1$ if he cares little about reputation, the cutoff value is lower for him to start reporting truthfully than in the other two cases.²¹ Proposition 4 also suggests that if $x_A, x_B > 0$, rules and policies increasing the cost for either agent to lie has a stronger effect on the agents' truth telling than that in the indirect case. This effect is particularly pronounced if both A and B are sufficiently concerned about their reputations. Because instead of lying more to offset B 's increasing truthfulness, A lies less. Together, this suggests that policies aiming to improve reporting accuracy from potentially biased sources should take a two-pronged approach: increasing the cost of distortion by intermediaries if both A, B have low to moderate levels of reputational concerns; and encouraging independent reporting, especially if the agents have high levels of reputational concerns. One way of achieving this is to build some distance between the source and the intermediary, perhaps by reducing the direct linkage between medical researchers, doctors and individual pharmaceutical companies. One recent instance to insulate medical research and treatment from industry influence is when the University of Pennsylvania Health System announced that industry can make gifts to departments to support educational programs (but not to individual faculty), while the money is disbursed at the discretion of department chiefs and chairs.

One caveat concerning policies encouraging independent reporting is that it may be counterproductive if both agents have sufficiently low reputational concerns that they always push their agenda. Because in this case, under indirect communication, C only receives one agenda-pushing message from biased B . Under independent reporting, however, she may receive two agenda-pushing messages which reinforce and strengthen each other. Due to the possible presence of objective agents, C is more persuaded by these messages. If agent A is very likely to be objective, this loss may be outweighed by the possibility of receiving a truthful m_A against B 's distortion. But if both agents are very biased, this exacerbates the decisionmaker's information loss. In situations where agents have a clear agenda and

²⁰ This complementarity is driven by each agent's decreasing marginal impact on C instead of changes in reputation cost as in Li (2007b), where the uncertainty of who initiates a wrong message creates a blame sharing effect and encourages each agent to lie more.

²¹ For instance, biased B starts reporting truthfully with some probability if $\beta < \frac{p_A(1-p_A)(1-\theta_B)}{1-\theta_B+p_A(1-p_A)\theta_B}$, which is strictly smaller than the cutoff value $\underline{\beta}$ in the indirect case.

little reputational concerns, then, it may be better to discourage independent reporting to reduce the quantity of distorted information, for example, reducing the amount of direct TV advertisements for prescription medicine.

4.2 Biased A 's Preference

Having considered some of the implications on the decisionmaker's expected payoff under independent reporting, one related question is biased A 's preference. That is, if he could choose an environment, either one with independent reporting or one with intermediary B , which would he prefer? Here we consider the ex ante payoffs of A before he receives his signal; in this way, his preference does not reveal information about his signal.

Two cases are particularly interesting, one is when A 's information has little influence on B ; and the other is when A needs to report truthfully sometimes with independent reporting, but not when he communicates through an intermediary.

Proposition 5 (Independent vs. Indirect Communication) *(5.1) If α and β are sufficiently low, A prefers independent reporting if θ_B is sufficiently close to 0.*

(5.2) If α and β are sufficiently high, A prefers using an intermediary.

The first part of Proposition 5 shows that if A and B have sufficiently low reputational concerns (or equivalently, if they are primarily motivated by pushing their agenda), A may prefer sending his own message. Because here A 's message has little influence on B , and in turn the decisionmaker, as shown in Proposition 2. Therefore A prefers an environment where C 's action favors his agenda more. If B 's message is not credible due to his low prior objectivity, A 's message has a stronger impact on C 's action than B 's. Doing so entails a lower posterior objectivity, which is negligible in this case. This suggests that if the intermediary, despite his better signal, is perceived to be very biased and not credible, A should not waste his information through B .

Next, if in equilibrium, A reports truthfully with some probability in both these environments, then the law of iterated expectation applies and his ex ante expected payoff is simply the sum of his priors: $\frac{1}{2} + \alpha\theta_A$. Hence he is indifferent. To see the second part of Proposition 5, recall that biased A always reports $m_A = 1$ if β is sufficiently high regardless of his own reputational concerns. In this case,

B reports so independently that A pays a negligible reputation cost; but he still has some influence on the decisionmaker. Thus he can “afford” to lie indirectly while he could not, at the same level of reputational concerns, if he sends a message of his own. If B faces sufficiently high reputational concerns, A is better off influencing him than risking losing his own reputation. This suggests that a pharmaceutical company with moderate to high reputational concerns always prefer using intermediaries who also have a moderately high reputation.

5 Discussions

Having examined the incentive problems biased A and B face in different environments involving either indirect communication or independent reporting, this section discusses several main assumptions on the agents’ information quality, preferences of the objective agent, as well as the distribution of state η . It also suggests how agents’ behavior may change if these assumptions were varied.

A. Relative informativeness of signals. Intermediary B ’s signal is assumed to be more accurate than that of A ’s, which implies that B is considered more objective if he appears free from A ’s influence. This model thus fits more closely the environments where the intermediary possesses good information such as experts, critics or physicians. There are also many contexts in which a source has superior and/or exclusive information, for example, government policy or military intelligence (Li 2007b). In that case, A ’s signal may be more informative ($p_B < p_A$) and an objective intermediary behaves differently. He follows A if it is unlikely that A has lied, but may dismiss it if biased A lies a lot: $m_B(m_A = 1, s_B = 0) = 0$ if $x \leq x_1$, $m_B(m_A = 1, s_B = 0) = 1$ otherwise. Note that the cutoff value x_1 increases in p_B . In particular, if B ’s signal is sufficiently uninformative, then an objective B always follows m_A , despite A ’s potential distortion. In this case, B serves as a pure intermediary, and biased A and B ’s truth telling become complements because they share the blame of any distortion.

B. Message space of agent B . The well-informed intermediary here sends a simple message $m_B \in \{0, 1\}$ to the decisionmaker C . One question is why the intermediary does not indicate both A ’s message as well as his own signal. One reason for restricting intermediary’s message space is that often experts only convey their recommendations as opposed to intensity to the decisionmaker, especially if the issue at stake is complex, for example whether to take a particular medicine. Another reason is that this

restriction helps illustrate the direction of B 's distortions: the bad information aggregation effect still exists. Even if the objective intermediary reports a vector of messages (m_A, s_B) truthfully, the biased type still has incentives to push one or both messages toward 1. Giving B a richer message space may not improve the information accuracy. For instance, if B 's reputational cost is sufficiently low, he may report $m_B = (1, 1)$ if $s_B = 0$ —which is more effective than $m_B = 1$ because it may result from both objective agents' signals are 1.

C. Role of the objective types. In this model, the objective agent has a preference for accuracy: he conveys the best information available. This assumption, consistent with the stated goals of experts such as stock analysts, critics and physicians, also greatly simplifies the inference problem of decisionmaker C . An objective agent $i = A, B$, however, may be concerned about his reputation as well as passing on accurate information such that an objective $i = A, B$ chooses m_i to maximize $Pr(\eta = s_i | m_i) + \lambda Pr(i = o | m_i, \eta)$, given his signal s_i . Morris (2001) shows in a model of direct communication that an objective expert may, instead of just reporting her information truthfully, lie because she doesn't want to be confused with a biased type and lose future influence. In the present model, similar incentives may arise if the objective intermediary is also concerned about his reputation. Recall that $m_B = 0$ but $\eta = 1$ is a good sign of B 's objectivity because it suggests that he is not influenced by $m_A = 1$. Thus an objective B has a stronger incentive to report 0 if $m_A = 0, s_B = 1$ than if he reports alone, which may drive A to report $m_A = 1$ more often, knowing that the objective B may avoid $m_B = 1$ on his own.

D. Asymmetric state distribution. In this model, the states are assumed to be ex ante symmetric, but the agents may believe that one state is more likely than the other, for instance patients may be suspicious of the effectiveness of a new drug: $Pr(\eta = 0) > \frac{1}{2}$. In this case, an objective A is less likely to pass on his positive signal if the prior beliefs are sufficiently extreme. That is, he may only report $m_A = 1$ with a small probability even if $s_A = 1$, which makes it less likely for objective B to report $m_B = 1$ to the decisionmaker as well even if $s_B = 1$. This increases the reputational cost and decreases the marginal benefit of agenda pushing for biased B , who becomes less likely to report $m_B = 1$. This effect may be exacerbated if there are many agents: sometimes the only equilibrium is an uninformative one in which nothing useful reaches the decisionmaker.

6 Conclusion

When well-informed intermediaries such as experts or physicians are used to influence the decisionmaker, independent judgment is a sign of objectivity. However, biased intermediaries selectively incorporate inferior and potentially distorted information before making their recommendations, which leads to wrong decisions on the part of the decisionmaker. When both the source and the intermediary have relatively low levels of reputational concerns, their truth-telling incentives tend to increase together, thus any policy measures raising the intermediary's reputational concerns increase the decisionmaker's payoff significantly. However, when they have very low or very high reputational concerns, such policy measures may be of little use or only marginally useful. Because one agent's truth-telling incentives decrease in the other's: as one reports more truthfully, the other lies more. A more effective measure is to encourage independent reporting by reducing the linkage between the source and the intermediary. Moreover, increasing the source's reputation concerns, when he has little to start with, may be counterproductive. It makes the source's information more useful, which increases the lying of a biased intermediary, making the decisionmaker strictly worse off.

A very biased source may avoid the intermediary who is too perceived to be overly biased because first, he has no influence on a sufficiently biased intermediary; and second, the intermediary's own message is too biased to influence the decisionmaker. The source, however, prefers communicating through an intermediary if both of them have relatively high reputational concerns, because he can still exert influence with little loss in his own reputation.

Appendix

Proof of Lemma 1:

Note that for an objective B , he sends $m_B = 0$ iff $Pr(\eta = 0|m_A, s_B) > \frac{1}{2}$ and sends $m_B = 1$ otherwise. Given biased A 's strategy described in the text, B 's estimates of the true state are:

$$\begin{aligned} \Gamma_1 &\equiv Pr(\eta = 0|m_A = 1, s_B = 0) \\ &= \frac{[1 - p_A + p_A(1 - \theta_A)(1 - x)]p_B}{[1 - p_A + p_A(1 - \theta_A)(1 - x)]p_B + [p_A + (1 - p_A)(1 - \theta_A)(1 - x)](1 - p_B)}; \\ \Gamma_2 &\equiv Pr(\eta = 0|m_A = 0, s_B = 0) = \frac{p_A p_B}{p_A p_B + (1 - p_A)(1 - p_B)}; \end{aligned}$$

$$\begin{aligned}\Gamma_3 &\equiv Pr(\eta = 0|m_A = 0, s_B = 1) = \frac{p_A(1-p_B)}{(1-p_B)p_A + p_A(1-p_B)}; \\ \Gamma_4 &\equiv Pr(\eta = 0|m_A = 1, s_B = 1) \\ &= \frac{[1-p_A + p_A(1-\theta_A)(1-x)](1-p_B)}{[1-p_A + p_A(1-\theta_A)(1-x)](1-p_B)[p_A + (1-p_A)(1-\theta_A)(1-x)]p_B}.\end{aligned}$$

Because B 's own signal is more accurate than that of A 's, simple calculations can show that $\Gamma_2 > \Gamma_1 > \frac{1}{2} > \Gamma_3 > \Gamma_4$. Thus B always reports $m_B = s_B$. \square

Proof of Proposition 1: Given A 's strategy described in the text, biased B chooses a message m_B to maximize his expected payoff, given his private information m_A, s_B . Let $\hat{\eta}_1^B \equiv Pr(\eta = 1|m_B = 1)$, $\hat{\eta}_0^B \equiv Pr(\eta = 1|m_B = 0)$. Then, the difference in B 's expected payoff from reporting $m_B = 1$ instead of $m_B = 0$ is:

$$\begin{aligned}&EU_B(m_B = 1|s_B, m_A) - EU_B(m_B = 0|s_B, m_A) \\ &= \hat{\eta}_1^B - \hat{\eta}_0^B - \beta Pr(\eta = 0|s_B, m_A)[Pr(B = o|m_B = 0, \eta = 0) - Pr(B = o|m_B = 1, \eta = 0)] \\ &\quad - \beta Pr(\eta = 1|s_B, m_A)[Pr(B = o|m_B = 0, \eta = 1) - Pr(B = o|m_B = 1, \eta = 1)].\end{aligned}$$

Observe that the difference in B 's information is captured in B 's estimate of the true state $Pr(\eta = 0|m_A, s_B)$: each estimate induces a different linear combination of C 's posterior estimate of his objectivity. To simplify notations, denote C 's posterior estimates of B 's objectivity respectively:

$$\begin{aligned}\tau_1 &\equiv Pr(B = o|m_B = 1, \eta = 0) \\ &= \frac{(1-p_B)\theta_B}{1-p_B + (1-\theta_B)p_B \left[(1-y_1)[1-p_A + p_A(1-\theta_A)(1-x)] + p_A(1-y_2)[\theta_A + (1-\theta_A)x] \right]}; \\ \tau_2 &\equiv Pr(B = o|m_B = 0, \eta = 0) \\ &= \frac{\theta_B}{\theta_B + (1-\theta_B)[y_1(1-p_A + p_A(1-\theta_A)(1-x)) + y_2 p_A(\theta_A + (1-\theta_A)x)]}; \\ \tau_3 &\equiv Pr(B = o|m_B = 0, \eta = 1) \\ &= \frac{\theta_B}{\theta_B + (1-\theta_B)[y_1(p_A + (1-p_A)(1-\theta_A)(1-x)) + y_2(1-p_A)(\theta_A + (1-\theta_A)x)]}; \\ \tau_4 &\equiv Pr(B = o|m_B = 1, \eta = 1) \\ &= \frac{p_B\theta_B}{p_B + (1-\theta_B)(1-p_B) \left[(1-y_1)[p_A + (1-p_A)(1-\theta_A)(1-x)] + (1-p_A)(1-y_2)[\theta_A + (1-\theta_A)x] \right]}.\end{aligned}$$

Then, for biased B to report truthfully, the following incentive constraints (IC) must be satisfied:

$$\hat{\eta}_1^B - \hat{\eta}_0^B \leq \Delta_1 \equiv \beta[\Gamma_1(\tau_2 - \tau_1) + (1 - \Gamma_1)(\tau_3 - \tau_4)]; \quad (IC_1^B)$$

$$\hat{\eta}_1^B - \hat{\eta}_0^B \leq \Delta_2 \equiv \beta[\Gamma_2(\tau_2 - \tau_1) + (1 - \Gamma_2)(\tau_3 - \tau_4)]; \quad (IC_2^B)$$

$$\hat{\eta}_1^B - \hat{\eta}_0^B \geq \Delta_3 \equiv \beta[\Gamma_3(\tau_2 - \tau_1) + (1 - \Gamma_3)(\tau_3 - \tau_4)]; \quad (IC_3^B)$$

$$\hat{\eta}_1^B - \hat{\eta}_0^B \geq \Delta_4 \equiv \beta[\Gamma_4(\tau_2 - \tau_1) + (1 - \Gamma_4)(\tau_3 - \tau_4)]. \quad (IC_4^B)$$

The first two incentive constraints (IC_1^B and IC_2^B) concern the case when $s_B = 0$ and the last two (IC_3^B and IC_4^B) concern the case when $s_B = 1$. The left hand side (LHS) of the above ICs, which is B 's net benefit from agenda pushing, is the same. The right hand side (RHS) of the above ICs measures B 's net reputation cost if he reports $m_B = 1$ versus $m_B = 0$, given m_A and his signal s_B . B 's reporting truthfulness depends on how large his net benefit of agenda-pushing is relative to his net reputation cost. Recall from Lemma 1 that $\Gamma_2 > \Gamma_1 > \Gamma_3 > \Gamma_4$, thus we can rank B 's net reputation cost. For instance, $\Delta_2 - \Delta_1 = (\Gamma_2 - \Gamma_1)[\tau_2 - \tau_3 + \tau_4 - \tau_1]$, and other comparisons are similar.

The term $[\tau_2 - \tau_3 + \tau_4 - \tau_1]$ is positive if B 's expected posterior reputation of giving correct predictions ($\tau_2 + \tau_4$) is larger than that of giving wrong predictions ($\tau_3 + \tau_1$); it is negative otherwise. Simple calculations can show that it is positive but decreasing in p_A at $p_A \approx \frac{1}{2}$, and may be negative at p_A sufficiently high. Because the difference is convex in p_A , there exists a cutoff value \bar{p}_A such that for all $p_A \leq \bar{p}_A$, the difference is always positive. Moreover, it is always positive if β is sufficiently high or close to 0; or if θ_B is sufficiently close to 1. Intuitively, all these cases guarantee that B is still better off, in equilibrium, to report accurately than to appear independent from A , which is also valuable to him in this model.

Next, let the probabilities that B reports his signal $s_B = 1$ truthfully given different messages from A be, respectively: $z_1 \equiv Pr(m_B = 1 | m_A = 0, s_B = 1)$, $z_2 \equiv Pr(m_B = 1 | m_A = 1, s_B = 1)$. For example, if B reports both signals truthfully, $y_1 = y_2 = z_1 = z_2 = 1$. The following lemma shows that biased B never lies if his signal supports his bias. If his signal does not support his bias, then he lies more if A 's message does ($m_A = 1$) than if it does not ($m_A = 0$).

Lemma 2 *In any (continuation) equilibrium, $z_1 = 1, z_2 = 1$. Also, $y_1 < y_2$ if $y_2 > 0$.*

Proof: given our assumption that A 's signal is sufficiently uninformative, by the argument above, $[\tau_2 - \tau_3 + \tau_4 - \tau_1] > 0$. Then B 's net reputation cost can be ranked such that $\Delta_2 > \Delta_1 > \Delta_3 > \Delta_4$. If none of the ICs bind, then it must be $z_1 = z_2 = 1, y_1 = y_2 = 0$. If any of the constraints is binding, there are two possibilities. First, suppose that $0 \leq z_1 < 1$, or $0 \leq z_2 < 1$, then IC_3^B or IC_4^B must be

binding, and $y_1 = y_2 = 1$, corresponding to the case when B reports $s_B = 0$ truthfully but lies with positive probability when $s_B = 1$. Then $m_B = 1$ implies $s_B = 1$, and $\hat{\eta}_1^B = p_B$, thus the net benefit for B to send $m_B = 1$ versus $m_B = 0$ is positive ($\hat{\eta}_1^B - \hat{\eta}_0^B > 0$). On the reputation side, however, we can show that $\tau_2 < \tau_1$ and $\tau_3 < \tau_4$. That is, B 's net reputation cost is negative. Together, B is strictly better off sending a positive message, thus he will deviate and report $m_B = 1$, which is a contradiction. Intuitively, in this putative equilibrium, a positive report is more likely to come from the objective B , and as such is both credible and also a good sign of objectivity. The second possibility is if $z_1 = 1, z_2 = 1, 0 \leq y_1 < y_2$. It can be checked that in this case, $[\tau_2 - \tau_3 + \tau_4 - \tau_1] > 0$, thus it is a possible (continuation) equilibrium.

If $[\tau_2 - \tau_3 + \tau_4 - \tau_1] < 0$, however, similar arguments can be used to show that no equilibrium exists in which both A and B lie with some probability to support their agenda as described in the text. \square

Given Lemma 2, we know that in equilibrium $z_1 = z_2 = 1$. Also, the only possible continuation equilibria are: $y_1 = y_2 = 0$, which is the case if neither IC_B^1 nor IC_B^2 holds; $y_2 > 0, y_1 = 0$ (it occurs when IC_B^2 binds) or $y_1 > 0, y_2 = 1$ (it occurs when IC_B^1 binds). We now proceed to characterize the continuation equilibria.

First, consider $\hat{\eta}_1^B - \hat{\eta}_0^B$, the possible gain in term of agenda pushing for a biased B , given his strategy. The inverses of $\hat{\eta}_1^B, \hat{\eta}_0^B$ are respectively:

$$\frac{1}{\hat{\eta}_1^B} = 1 + \frac{1 - p_B + p_B(1 - \theta_B) \left[(1 - y_1)[1 - p_A + p_A(1 - \theta_A)(1 - x)] + (1 - y_2)p_A[\theta_A + (1 - \theta_A)x] \right]}{p_B + (1 - p_B)(1 - \theta_B) \left[(1 - y_1)[p_A + (1 - p_A)(1 - \theta_A)(1 - x)] + (1 - y_2)(1 - p_A)(\theta_A + (1 - \theta_A)x) \right]};$$

$$\frac{1}{\hat{\eta}_0^B} = 1 + \frac{p_B \left[\theta_B + (1 - \theta_B)y_1[1 - p_A + p_A(1 - \theta_A)(1 - x)] + (1 - \theta_B)p_A y_2[\theta_A + (1 - \theta_A)x] \right]}{(1 - p_B) \left[\theta_B + (1 - \theta_B)y_1[p_A + (1 - p_A)(1 - \theta_A)(1 - x)] + (1 - \theta_B)(1 - p_A)y_2(\theta_A + (1 - \theta_A)x) \right]}.$$

Simple calculation can show that at $\hat{\eta}_1^B$ increases in y_1, y_2 while $\hat{\eta}_0^B$ increases in y_1 but decreases in y_2 . Moreover, $\frac{\partial^2 \hat{\eta}_1^B}{\partial y_1^2} > 0$, $\frac{\partial^2 \hat{\eta}_0^B}{\partial y_1^2} < 0$. In addition, $\frac{\partial \hat{\eta}_1^B}{\partial y_1} - \frac{\partial \hat{\eta}_0^B}{\partial y_1} > 0$ at $y = 0$, therefore $\hat{\eta}_1^B - \hat{\eta}_0^B$ increases in y_1 and y_2 . At $y_1 = y_2 = 0$, i.e., if biased B lies completely, $\hat{\eta}_1^B - \hat{\eta}_0^B = \frac{2p_B - 1}{1 + (1 - \theta_B)} > 0$. Thus B 's net benefit from agenda pushing is always positive, because of the presence of the objective B ; it is also increasing in B 's reporting truthfulness y_1, y_2 .

Step 1: No truthful revelation equilibrium. To begin with, if B always reports truthfully ($y_1 = y_2 = z_1 = z_2 = 1$), then $[\tau_2 - \tau_3 + \tau_4 - \tau_1] = 0$, because C does not update her belief about B 's objectivity

at all. This means that B has zero reputation cost, but his benefit of reporting $m_B = 1$ is positive, and he will deviate, a contradiction.

Step 2: Total distortion equilibrium. When would a biased B lie completely if his signal does not support his bias? At $y_1 = y_2 = 0$, B 's highest reputation cost occurs if $s_B = 0, m_A = 0$, which becomes: $\Delta_2 = \beta(1 - \theta_B)[\frac{\Gamma_2}{1-p_B\theta_B} + \frac{1-\Gamma_2}{1-(1-p_B)\theta_B}]$. This is the case for B to lie against two signals against his bias. It can be shown that if $\beta \leq \frac{2p_B-1}{2-\theta_B}$, or if $\theta_B \approx 1$, the benefit of lying outweighs B 's reputation cost, and he lies completely. When $\hat{\eta}_1^B - \hat{\eta}_0^B \leq \Delta_2$ at $y_1 = y_2 = 0$, however, B 's expected reputation cost is too high for him to lie completely. This occurs if β is sufficiently high. For example, if $\beta \geq 1$, B reports truthfully with some probability.

Step 3: Strong and weak distortion equilibrium. When $\hat{\eta}_1^B - \hat{\eta}_0^B \leq \Delta_2$ at $y_1 = y_2 = 0$, which is the case if β is sufficiently high, B 's expected reputation cost is too high for him to lie completely. There are two possibilities: either a strong distortion equilibrium ($y_1 = 0, y_2 > 0$), or a weak distortion equilibrium ($y_2 = 1, y_1 > 0$) may occur. To learn which equilibrium occurs, we need to compare B 's net benefit of lying $\hat{\eta}_1^B - \hat{\eta}_0^B$ with his net reputation cost Δ_2 for any given x . In particular, at $y_1 = 0, y_2 = 1$: If B 's net benefit is higher than his net cost, then $y_1 = 0, y_2 > 0$ is part of the equilibrium. The mixing probability y_2 is determined by a binding IC_B^2 . Otherwise, $y_1 > 0, y_2 = 1$ is part of the equilibrium, and the mixing probability y_1 is determined by a binding IC_B^1 . Because B 's maximum benefit from lying is bounded away from 1, thus for any given x , there exists a cutoff value $\bar{\beta}$ such that if $\beta \leq \bar{\beta}$, the unique continuation equilibrium is a strong distortion one and if $\beta \geq \bar{\beta}$, the unique continuation equilibrium involves weak distortion.

Also, we can see how B reacts to A 's truth-telling. Note that the relative benefit of lying is increasing in y_1, y_2 . Moreover, it varies with x in the following way:

$$\begin{aligned} \text{sign}\left(\frac{\partial \hat{\eta}_1^B}{\partial x}\right) &= \text{sign}((y_2 - y_1)[p_B^2 p_A - (1 - p_B)^2(1 - p_A) + p_B(1 - p_B)(1 - \theta_A)(2p_A - 1)(1 - y_1)]); \\ \text{sign}\left(\frac{\partial \hat{\eta}_0^B}{\partial x}\right) &= \text{sign}((y_1 - y_2)(2p_A - 1)[\theta_B + (1 - \theta_B)y_1]). \end{aligned}$$

Thus when $y_2 > y_1$, which is the case in equilibrium, the gain in agenda pushing increases in x as well. On the other hand, simple algebra can show that $\tau_2 - \tau_1$, and $\tau_3 - \tau_4$ decrease in y_1, y_2 and x . Because Γ_2 does not depend on x , Δ_2 decreases in all three mixing probability: the more truthful A and B are, the less C changes her estimates of their objectivity.

The remaining case is when IC_B^1 is binding, in which case we have $\frac{\partial \Gamma_1}{\partial x} < 0$ and $\text{sign}(\frac{\partial \Delta_1}{\partial x}) = \text{sign}(\frac{\partial \Gamma_1}{\partial x}(\tau_2 - \tau_1 - \tau_3 + \tau_4)) < 0$. Thus the reputation cost Δ_1 decreases in the mixing probabilities as well. Thus for a given $x > 0$, if x decreases, the gain in agenda pushing for B (left hand side) decreases while the reputation cost (right hand side) increases. \square

Proof of Proposition 2: Given the continuation equilibria of B , A 's expected benefit from agenda pushing after receiving signal $s_A = 0$ and $s_A = 1$ is respectively:

$$\begin{aligned} & E_{m_B}[Pr(\eta = 1|m_B)|m_A = 1, s_A = 0] - E_{m_B}[Pr(\eta = 1|m_B)|m_A = 0, s_A = 0] \\ &= (1 - \theta_B)(y_2 - y_1)[p_A p_B + (1 - p_A)(1 - p_B)](\hat{\eta}_1^B - \hat{\eta}_0^B); \\ & E_{m_B}[Pr(\eta = 1|m_B)|m_A = 1, s_A = 1] - E_{m_B}[Pr(\eta = 1|m_B)|m_A = 0, s_A = 1] \\ &= (1 - \theta_B)(y_2 - y_1)[p_A(1 - p_B) + p_B(1 - p_A)](\hat{\eta}_1^B - \hat{\eta}_0^B). \end{aligned}$$

Note that A 's message only has an effect if B is biased, and $y_2 - y_1 > 0$: that is, B may change his message based on what he hears. If $y_2 = y_1 = 0$, A 's message has no effect on the decisionmaker C .

Next, A 's expected reputation if he receives $s_A = 0$ but sends $m_A = 1$ is:

$$\begin{aligned} & E_{\eta, m_B}[Pr(A = o|m_B, \eta)|m_A = 1, s_A = 0] \\ &= (\theta_B + (1 - \theta_B)y_1)[p_A p_B Pr(A = o|m_B = 0, \eta = 0) + (1 - p_A)(1 - p_B)Pr(A = o|m_B = 0, \eta = 1)] \\ &+ (1 - \theta_B)(1 - y_1)[p_A p_B Pr(A = o|m_B = 1, \eta = 0) + (1 - p_A)(1 - p_B)Pr(A = o|m_B = 1, \eta = 1)] \\ &+ p_A(1 - p_B)Pr(A = o|m_B = 1, \eta = 0) + p_B(1 - p_A)Pr(A = o|m_B = 1, \eta = 1)]. \end{aligned}$$

Note that the last part is the effect on A 's reputation when B sends $m_B = 1$ because his signal is positive. Similar to before, the net difference in A 's expected payoff if he sends $m_A = 1$ versus $m_A = 0$ for a given signal s_A is crucial for his truthful reporting. Let $\kappa = (1 - \theta_B)(y_2 - y_1)$, then for biased A to report truthfully, the following two incentive constraints must hold. They respectively require that A is willing to report $s_A = 0$ and $s_A = 1$ truthfully:

$$\begin{aligned} \kappa(\hat{\eta}_1^B - \hat{\eta}_0^B) &\leq \frac{\kappa \alpha p_A p_B}{p_A p_B + (1 - p_A)(1 - p_B)} [Pr(A = o|m_B = 0, \eta = 0) - Pr(A = o|m_B = 1, \eta = 0)] \\ &+ \frac{\kappa \alpha (1 - p_A)(1 - p_B)}{p_A p_B + (1 - p_A)(1 - p_B)} [Pr(A = o|m_B = 0, \eta = 1) - Pr(A = o|m_B = 1, \eta = 1)]; \quad (1) \\ \kappa(\hat{\eta}_1^B - \hat{\eta}_0^B) &\geq \frac{\kappa \alpha (1 - p_A) p_B}{p_A(1 - p_B) + p_B(1 - p_A)} [Pr(A = o|m_B = 0, \eta = 0) - Pr(A = o|m_B = 1, \eta = 0)] \end{aligned}$$

$$+ \frac{\kappa\alpha p_A(1-p_B)}{p_A(1-p_B) + p_B(1-p_A)} [Pr(A = o|m_B = 0, \eta = 1) - Pr(A = o|m_B = 1, \eta = 1)]. \quad (2)$$

Next, A is also concerned about how objective C thinks he is after each possible message from B and the realized true state. Using Bayes' rule, we have:

$$\begin{aligned} Pr(A = o|m_B = 0, \eta = 0) &= \frac{\theta_A[\theta_B + p_A(1-\theta_B)y_2 + (1-p_A)(1-\theta_B)y_1]}{p_A(\theta_A + (1-\theta_A)x)(\theta_B + (1-\theta_B)y_2) + [1-p_A(\theta_A + (1-\theta_A)x)](\theta_B + (1-\theta_B)y_1)}; \\ Pr(A = o|m_B = 1, \eta = 0) &= \frac{\theta_A[1-p_B + p_A p_B(1-\theta_B)(1-y_2) + (1-p_A)p_B(1-\theta_B)(1-y_1)]}{1-p_B + p_B(1-\theta_B)[p_A(\theta_A + (1-\theta_A)x)(1-y_2) + (1-p_A(\theta_A + (1-\theta_A)x))(1-y_1)]}; \\ Pr(A = o|m_B = 0, \eta = 1) &= \frac{\theta_A[\theta_B + (1-p_A)(1-\theta_B)y_2 + p_A(1-\theta_B)y_1]}{(1-p_A)(\theta_A + (1-\theta_A)x)(\theta_B + (1-\theta_B)y_2) + [1-(1-p_A)(\theta_A + (1-\theta_A)x)](\theta_B + (1-\theta_B)y_1)}; \\ Pr(A = o|m_B = 1, \eta = 1) &= \frac{\theta_A[p_B + (1-p_A)(1-p_B)(1-\theta_B)(1-y_2) + p_A(1-p_B)(1-\theta_B)(1-y_1)]}{p_B + (1-p_B)(1-\theta_B)[(1-p_A)(\theta_A + (1-\theta_A)x)(1-y_2) + (1-(1-p_A)(\theta_A + (1-\theta_A)x))(1-y_1)]}. \end{aligned}$$

Now we can compare the difference in A 's expected payoffs if $s_A = 0$ instead of $s_A = 1$. Simple calculations show that $EU_A(m_A = 1|s_A = 0) - EU_A(m_A = 0|s_A = 0) > EU_A(m_A = 1|s_A = 1) - EU_A(m_A = 0|s_A = 1)$, or whenever A mixes or prefers reporting $m_A = 1$ when $s_A = 0$, he strictly prefers reporting $m_A = 1$ when $s_A = 1$. Intuitively, A has less to lose in term of reputation if $s_A = 1$, because he thinks that it is more likely that $\eta = 1$ if $s_A = 1$, thus B is more likely to report $m_B = 1$ correctly, which is a less negative sign of A 's objectivity. This also shows that $m_B = 0$ is a better sign of A 's objectivity. The reason is that A 's message only affect that of B 's when B is biased and $s_B = 0$. In that case, because $y_2 > y_1$, $m_B = 0$ is a better signal that $m_A = 0$.

To know A equilibrium behavior if $s_A = 0$, first recall from Proposition 1 that if $\beta \leq \frac{2p_B-1}{1+(1-\theta_B)}$ or if $\theta_B \approx 1$, B always reports $m_B = 1$ ($y_1 = y_2 = 0$). In this case, A 's message has no influence at all on C , thus he can report in any way: $x \in [0, 1]$.

Second, if $y_2 > 0$, A 's message influences B by changing his message with some probability. Observe that A 's net reputation cost (the RHS of IC (1)) can be shown to be proportional to $\alpha\theta_A(1-\theta_A)(1-x)(1-\theta_B)(y_2 - y_1)$. Clearly, A reports $x = 0$ if his net reputation cost is approximately 0, which is strictly less than the positive net agenda-pushing effectiveness $\hat{\eta}_1^B - \hat{\eta}_0^B$. This may occur for three reasons. To begin with, because the LHS of IC (1) is strictly positive, there exists a cutoff value $\underline{\alpha}$ such

that IC (1) binds at $x = 0, y_1 = 0, y_2 = 1$. If $\alpha \leq \underline{\alpha}$, then IC (1) fails to hold for any $x > 0$ because the net benefit for A to lie to push his agenda is higher than the maximum reputation cost he has to pay; if $\alpha \geq \underline{\alpha}$ instead, $x > 0$ for at least some value of β . Next, A 's perceived objectivity is not responsive to his messages due to his extreme prior objectivity ($\theta_A \approx 0$ or 1). Finally, it may occur because A has negligible influence on B ($y_2 \approx y_1$). Note that the last case is true if either $y_2 \approx 0$, which occurs when β is sufficiently low, or if $y_1 \approx 1$, which occurs when β is sufficiently high, A lies completely because his impact on B , and hence his perceived objectivity is negligible.

Third, recall that if β is sufficiently high, one of B 's incentive constraints IC_B^1 or IC_B^2 binds; and for A , IC (1) is the key constraint. Let IC_B^1 and IC_B^2 implicitly define the best response of B to x : $y_1^{BR}(x; y_2 = 1)$ and $y_2^{BR}(x; y_1 = 0)$. Recall that only one of these best responses can be strictly between 0 and 1. We know from above that $x^{BR}(y_2 = 0) = 0$, and $x^{BR}(y_2 = 1) = 0$ if α is sufficiently low, in which case A always reports $m_A = 1$; or $x^{BR}(y_2 = 1) > 0$ if α is sufficiently high. Because y_2 decreases in x , thus if $y_2^{BR}(x = 1; y_1 = 0) < 1$, $y_2^{BR}(x = 0; y_1 = 0) > y_2^{BR}(x = 1; y_1 = 0) \geq 0$. Because $x, y_2 \in [0, 1]$, by the intermediate value theorem, the two best responses intersect, and there exists a strong distortion equilibrium in which $x \in [0, 1], y_2 \in (0, 1)$.

If, however, $y_2^{BR}(x = 1; y_1 = 0) \geq 1$, then no strong distortion equilibrium exists. That is, if IC_B^2 does not hold at $x = 1, y_1 = 0, y_2 = 1$, then recall that x decreases in y_1 and y_1 decreases in x . Note that $y_1^{BR}(x = 0) < 1$ and $x^{BR}(y_1 = 1) = 0$ because at $y_1 \approx 1$, A has no influence. Moreover, $y_2^{BR}(x = 1; y_1 = 0) \geq 1$ implies that $y_1^{BR}(x = 1) > 0$, and $0 \leq x^{BR}(y_1 = 0) < 1$ because this is the case when A has a lot of influence and he prefers to lie as long as α is sufficiently high. This guarantees that the two best responses intersect and there exists a strong distortion equilibrium in which $x \in [0, 1), y_1 \in (0, 1)$.

Finally, if α is sufficiently high and if $y_2^{BR}(x = 0; y_1 = 0) > 1$ and $y_2^{BR}(x = 1; y_1 = 0) < 1$, there may exist multiple equilibria such that $x_1 > 0, y_2 > 0$ and $x_2 > 0, y_1 > 0$. To see this, note from biased B 's incentive constraint IC_B^2 in the proof of Proposition 1 that if $y_2^{BR}(x = 0; y_1 = 0) \leq 1$, then for any x , only a strong distortion equilibrium may exist; if $y_2^{BR}(x = 1; y_1 = 0) \geq 1$ instead, then for any value of x , only a weak distortion equilibrium exists. In particular, let β_1 be the value such that IC_B^2 binds at $x = 0, y_1 = 0, y_2 = 1$ and $\bar{\beta}$ be the value such that IC_B^2 binds at $x = 1, y_1 = 0, y_2 = 1$. Then multiple equilibria may occur only if $\beta \in [\beta_1, \bar{\beta})$. Intuitively, in this range, B 's behavior is very sensitive to A 's

behavior. Thus if $m_A = 1$ is very credible, for instance because B 's signal quality is not too much higher than that of A 's or if A faces very high reputational concerns, B can rely more on A 's message and lie more in a strong distortion equilibrium. But if $m_A = 1$ is not very credible, then B prefers relying on his own signal more, which gives rise to a weak distortion equilibrium. \square

Proof of Proposition 3: From the proof of Proposition 1 and Proposition 2, we know that for $p_A \leq \bar{p}_A$, an equilibrium involving distorting signal $s_A = 0$ or $s_B = 0$ exists. In particular, if α is sufficiently large and β is not too large, all the mixing probabilities x, y_1, y_2 are positive. Moreover, y_1 decreases in x ; and x decreases in y_1 . Thus x, y_1 are substitutes: whenever one of these mixing probability increases, the other decreases.

As shown in Proposition 1, y_2 increases in x . However, A 's best response with respect to y_2 is ambiguous because both his net agenda pushing effectiveness and his net reputation cost increase in y_2 . However, if p_B is sufficiently high, use A 's equilibrium mixing condition (1), it can be shown that A 's agenda-pushing effectiveness (the LHS of 1) increases less in y_2 than his reputation cost (the RHS of (1)). Thus the increase in A 's reputation cost dominates, and A becomes more honest as B does: x increases in y_2 . Thus if p_B is sufficiently high, y_2 increases in x and vice versa. Intuitively, biased B follows A 's message in a strong distortion equilibrium, thus as B 's signal becomes more precise, a wrong message is more likely due to A 's distortion. \square

Proof of Proposition 4: Let the weights on reputation be α_i, α_j respectively. Similarly, the signal quality is p_i, p_j respectively and their truthful reporting probabilities be x_i, x_j respectively. Recall from the text that here biased $i = A, B$ maximizes:

$$E_{m_j}[Pr(\eta = 1|m_i, m_j)|s_i] + E_\eta[Pr(i = o|m_i, \eta)|s_i].$$

To simplify notations, let C 's belief that the true state is 1, which is also her optimal action, $Pr(\eta = 1|m_i = 0, m_j = 0)$ be denoted as $Pr(1|0, 0)$; other beliefs are similarly denoted. Observe that agent j 's message does not affect the posterior estimate of agent i because C evaluates i after observing the true state. However, m_j affects the marginal impact of i 's message can induce in C 's action.

In particular, for biased i to report truthfully, the following two incentive constraints must hold:

$$Pr(m_j = 1|s_i = 0)[Pr(1|1, 1) - Pr(1|0, 1)] + Pr(m_j = 0|s_i = 0)[Pr(1|1, 0) - Pr(1|0, 0)]$$

$$\geq \alpha_i \sum_{\eta} Pr(\eta|s_i = 0)[Pr(i = o|m_i = 1, \eta) - Pr(i = o|m_i = 0, \eta)]; \quad (3)$$

$$\begin{aligned} & Pr(m_j = 1|s_i = 0)[Pr(1|1, 1) - Pr(1|0, 1)] + Pr(m_j = 0|s_i = 0)[Pr(1|1, 0) - Pr(1|0, 0)] \\ & \geq \alpha_i \sum_{\eta} Pr(\eta|s_i = 0)[Pr(i = o|m_i = 1, \eta) - Pr(i = o|m_i = 0, \eta)]. \end{aligned} \quad (4)$$

Because Given the agenda pushing strategies, the decisionmaker's action after hearing both messages becomes:

$$\begin{aligned} Pr(1|0, 0) &= \frac{(1-p_i)(1-p_j)}{p_i p_j + (1-p_i)(1-p_j)}; \\ Pr(1|0, 1) &= \frac{(1-p_i)[1 - (1-p_j)(\theta_j + (1-\theta_j)x_j)]}{(1-p_i)[1 - (1-p_j)(\theta_j + (1-\theta_j)x_j)] + p_i[1 - p_j(\theta_j + (1-\theta_j)x_j)]}; \\ Pr(1|1, 0) &= \frac{(1-p_j)[1 - (1-p_i)(\theta_i + (1-\theta_i)x_i)]}{(1-p_j)[1 - (1-p_i)(\theta_i + (1-\theta_i)x_i)] + p_j[1 - p_i(\theta_i + (1-\theta_i)x_i)]}; \\ Pr(1|1, 1) &= \frac{1}{1 + \frac{[1-p_j(\theta_j+(1-\theta_j)x_j)]}{[1-(1-p_j)(\theta_j+(1-\theta_j)x_j)]} \cdot \frac{[1-p_i(\theta_i+(1-\theta_i)x_i)]}{[1-(1-p_i)(\theta_i+(1-\theta_i)x_i)]}}. \end{aligned}$$

Moreover, because of the presence of objective agent, it is simple to show that $Pr(1|1, 1) > Pr(1|0, 1)$ and $Pr(1|1, 0) > Pr(1|0, 0)$. Next, it can also be shown that the difference $Pr(1|1, 1) - Pr(1|0, 1) - [Pr(1|1, 0) - Pr(1|0, 0)] > 0$. Intuitively, $m_i = 1$ has a higher marginal impact in term of agenda pushing if m_j supports rather than contradicts i 's message. The reason is that relative to the case with only objective agents, biased i is more likely to distort when $\eta = 0$ than when $\eta = 1$, in which case his signal is more likely to be $s_i = 1$ and he does not distort. Therefore if $m_j = 0$, the decisionmaker infers that it is more likely that $\eta = 0$, and $m_i = 1$ is more likely to be a result of distortion than if $m_j = 1$, which lends more support for $\eta = 1$.

This also implies that if IC (3) binds or fails to hold, IC (4) holds strictly. The reason is that if $s_i = 1$, it is more likely that $s_j = 1$ as well, thus the agenda pushing effectiveness is higher for i to report $m_j = 1$ as opposed to $m_i = 0$. On the other hand, the net reputation cost is smaller for i if $s_i = 1$ because his message $m_i = 1$ is more likely to be correct. Thus i always reports $s_i = 1$ truthfully.

Next, differentiate i 's agenda pushing effectiveness (the LHS of IC (3) with respect to x_j , and we have up to a factor $(1 - \theta_j)$:

$$\begin{aligned} & Pr(m_j = 1|s_i = 0) \left[\frac{\partial}{\partial x_j} (Pr(1|1, 1)) - \frac{\partial}{\partial x_j} (Pr(1|0, 1)) \right] \\ & - [p_i p_j + (1-p_i)(1-p_j)] [Pr(1|1, 1) - Pr(1|0, 1) - [Pr(1|1, 0) - Pr(1|0, 0)]]. \end{aligned}$$

From the discussion above, the second line is clearly negative. Moreover, $\frac{\partial}{\partial x_j}(Pr(1|1, 1)) < \frac{\partial}{\partial x_j}(Pr(1|0, 1))$. Thus i 's net benefit from lying is decreasing in x_j . Therefore x_i increases in x_j . The biased agents' truth-telling probabilities are complements because if one becomes more truthful, the other has a smaller (expected) marginal impact on C , thus he lies less as well. \square

Proof of Proposition 5: Consider independent reporting first. Suppose that in equilibrium, A reports $s_A = 0$ with positive probability x_A , then his ex ante expected payoff becomes:

$$\begin{aligned} EU_A^1 &\equiv E_{s_A} \left[E_{m_B} [Pr(\eta = 1|m_A, m_B)|s_A] + \alpha E_\eta [Pr(A = o|m_A, \eta)|s_A] \right] \\ &= \frac{1}{2} [(1 + (1 - \theta_B)(1 - x_B))Pr(1|1, 1) + (\theta_B + (1 - \theta_B)x_B)Pr(1|1, 0)] \\ &\quad + \alpha Pr(A = o|m_A = 1). \end{aligned} \tag{5}$$

Intuitively, because A is indifferent between reporting $m_A = 1$ or $m_A = 0$ if $s_A = 0$, while he strictly prefers reporting $m_A = 1$ if $s_A = 1$, his expected payoff is the same as if he always reports $m_A = 1$. Moreover, biased A 's ex ante payoff can be compared with a sum of C 's prior beliefs $\frac{1}{2} + \alpha\theta_A$:

$$\begin{aligned} &EU_A^1 - \left(\frac{1}{2} + \alpha\theta_A\right) \tag{6} \\ &= EU_A^1 - \sum_{l,k \in \{0,1\}} Pr(m_A = l, m_B = k)Pr(\eta = 1|m_A = l, m_B = k) - \sum_{l \in \{0,1\}} \alpha Pr(m_A = l)Pr(A = o|m_A = l) \\ &= Pr(m_A = 0) \left[Pr(m_B = 1|s_A = 0)[Pr(1|1, 1) - Pr(1|0, 1)] + Pr(m_B = 0|s_A = 0)[Pr(1|1, 0) - Pr(1|0, 0)] \right] \\ &\quad - \alpha Pr(m_A = 0)[Pr(A = o|m_A = 0) - Pr(A = o|m_A = 1)] \\ &= 0. \end{aligned}$$

The first equality is due to the law of iterated expectations, while the last one is due to biased A 's equilibrium mixing condition IC (3), as given in Proposition 4. Therefore if biased A cares sufficiently about his reputation to report $m_A = 0$ sometimes, his net gain in term of agenda-pushing effectiveness must exactly be equal to his loss in posterior objectivity.

Second, if A can exert influence through intermediary B ($\max\{y_1, y_2\} > 0\}$), and suppose that in equilibrium $x > 0$, biased A 's ex ante expected payoff from indirect communication is:

$$\begin{aligned} &EU_A^2 \\ &= \frac{1}{2} [1 + (1 - \theta_B)(1 - y_1)] [Pr(\eta = 1|m_B = 1) + \alpha Pr(A = o|m_B = 1, \eta = 1) + \alpha Pr(A = o|m_B = 1, \eta = 0)] \end{aligned}$$

$$+ \frac{1}{2}[\theta_B + (1 - \theta_B)y_1][Pr(\eta = 1|m_B = 0) + \alpha Pr(A = o|m_B = 0, \eta = 1) + \alpha Pr(A = o|m_B = 0, \eta = 0)]. \quad (7)$$

Similar argument can show that $EU_A^2 = \frac{1}{2} + \alpha\theta_A$ if there exists a fully mixed equilibrium where both A , B report signal against their agenda with some positive probability. Thus if $x_A > 0, x > 0, \max\{y_1, y_2 > 0\} > 0$, A is indifferent in ex ante terms between these two ways of communication.

Next, if biased A strictly prefers lying, then his ex ante expected payoff is strictly higher than the prior: $\frac{1}{2} + \alpha\theta_A$. For instance, suppose that $x_A = 0$. Then A 's reputational cost is so low that $EU_A^1(m_A = 1|s_A = 0) > EU_A^1(m_A = 0|s_A = 0)$ at $x_A = 0$, thus he is worse off if he reports truthfully with any infinitesimally small probability. To see this, note that Expression (6) is strictly positive because A 's mixing constraint IC (3) no long binds.

Recall from Proposition 4 that A always reports $m_A = 1$ if α is sufficiently low or if θ_A is sufficiently high. A simple comparison of A 's ex ante expected payoffs can show that if β is sufficiently low that $y_1 = 0$, then A prefers independent reporting if θ_B is sufficiently close to 0. Formally, this is because $Pr(\eta = 1|1, 1) > Pr(\eta = 1|m_B = 1)$. Otherwise, A prefers communicating through an intermediary.

Finally, if β is sufficiently high, biased A always reports $m_A = 1$ with indirect communication, regardless of his own reputational concerns. Therefore A with moderately high reputational concerns—who would report $s_A = 0$ truthfully with some probability if he sends his own message—always prefers indirect communication if the intermediary is very concerned about his reputation. \square

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